Vinyard Creek Agricultural Drain Water Quality Monitoring Report

Jerome County, Idaho

Developed for:

North Side Soil and Water Conservation District
Mid-Snake Watershed Advisory Group

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August 2001

Technical Results Summary #1

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By Mark V. Dallon

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Executive Summary

Vinyard Creek is a short, spring fed tributary of the Snake River in southern Jerome County, Idaho. Until recently an agricultural return drain discharged into Vinyard Creek and degraded water quality and fish habitat in the lower portion of the creek. Vinyard Creek is an important spawning stream for salmonids in the Snake River. The North Side Soil and Water Conservation District applied for and received funding through the state of Idaho to reduce levels of sediment, nutrients and bacteria entering Vinyard Creek by implementing agricultural best management practices (BMPs) in the upstream watershed. The funding was granted through the State Agricultural Water Quality Program (SAWQP) and cost sharing and implementation of practices began in 1986. Project goals were to reduce sediment loads by 80% and phosphorous loads by 70%.

Prior to 1986, total suspended solids (TSS) and total phosphorous loads discharging into Vinyard Creek were measured at levels exceeding recommended water quality standards. Data collected during a study prior to implementation of practices in 1986 showed TSS concentrations that averaged 166 mg/L, well above the suggested levels of 25 mg/L – 75 mg/L. Total phosphorous concentrations averaged 0.26 mg/L, also well above the recommended concentration of 0.10 mg/L.

Implementation of BMPs was aimed at reducing sediment delivery to Vinyard Creek from irrigated cropland. Priority areas for implementation of practices were determined to improve efficiency of cost share funds and extensive efforts were made to educate and encourage landowners to implement practices independently as well. The primary practices implemented were improved irrigation systems (sprinkler systems, concrete ditch), conservation tillage, no-till and construction of sediment basins. In addition, the North Side Canal Company has installed several sediment basins in the watershed to reduce sediment delivery. The change in irrigation practices resulted in a large-scale change from flood irrigation to sprinkler irrigation in the Vinyard Creek watershed. Sprinkler irrigation accounted for 12% of the total watershed area in 1986 and 73% in 1999. This change had a large impact on agricultural runoff.

IASCD water quality monitoring during the 1999 irrigation season showed considerable decrease in TSS and total phosphorous concentrations as well as decreased flow in the agricultural drain. The most downstream site (near the mouth) had an average TSS concentration of 19 mg/L and a total phosphorous concentration of 0.10 mg/L, both at or well below the standards set in the Upper Snake Rock Total Maximum Daily Load. Stream discharge at the downstream location dropped from 7.7 cfs in 1986 to 2.5 cfs in 1999. Overall, TSS loads decreased by 96% and total phosphorous by 90% from 1986 to 1999.

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Acknowledgements

A number of people were instrumental in implementing this monitoring project. The entire project was requested and made possible by the North Side Soil and Water Conservation District board and NRCS staff in Jerome. Without the successful implementation of the Vinyard Creek SAWQP over the last 15 years there would have been little interest in water quality in the Vinyard Creek drain and fewer land management changes would have been made. They provided valuable information about land ownership, BMPs that have been implemented and assisted in monitoring site determination. Tom Burnham of the NRCS was particularly helpful in discussing land ownership, land acreage and changes in land practices.

Personnel at the DEQ Twin Falls Regional Office deserve thanks for providing prior water quality data from the Vinyard Creek watershed from previous monitoring. Kirk Campbell and Gary Bahr of the Idaho State Department of Agriculture provided valuable technical assistance, training, edits and suggestions.

Introduction

During the 1999 irrigation season the Idaho Association of Soil Conservation Districts (IASCD) collected water quality data on the Vinyard Creek agricultural drain in Jerome County, Idaho. The project was designed to assist the North Side Soil and Water Conservation District (SWCD) in determining changes in water quality in the drain after several years of implementation of agricultural best management practices in the watershed. From May through October of 1999 three (3) sites in the Vinyard Creek watershed were monitored for several water quality parameters to compare results with those from previous years.

The Vinyard Creek drain is an irrigation conveyance system. Originally diverted from the Snake River at Milner Dam, irrigation water flows through a series of main canals and drains and discharges into the Snake River at Twin Falls Reservoir. The drain flows from mid April to late October and is dry during the non-irrigation season, except for minor runoff from snowmelt and storms during winter months. The discharge and concentration of pollutants in the drain are dependent on agricultural practices and irrigation management in the watershed. The area draining into Vinyard Creek encompasses 9890 acres, 81% of which is managed for irrigated agriculture (North Side SCD, 1986).

Vinyard Creek is a short, spring fed creek within the Snake River Canyon. Prior to 1998, the agriculture drain emptied into Vinyard Creek approximately 200 meters above the creek's confluence with the Snake River at Twin Falls Reservoir. Because of the input of agricultural pollutants to Vinyard Creek and the degradation of beneficial uses in the creek, the North Side SWCD applied for and received funding through the State Agricultural Water Quality Program (SAWQP) in 1986. The funding provided money to implement best management practices (BMPs) and educate area landowners in water quality issues. Implementation of practices, primarily on irrigated agricultural land, began in 1986. The location of the Vinyard Creek SAWQP area is shown in Figure 1.

The Idaho Soil Conservation Commission (SCC) administered the SAWQP through the North Side SWCD. The Natural Resources Conservation Service (NRCS) provided additional assistance with the implementation of practices. Previous water quality data was collected by the Idaho State Department of Health and Welfare, Division of Environmental Quality (DEQ) in 1986 and again in the early 1990's. The three sites monitored by IASCD during the 1999 irrigation season were used to replicate sites monitored during the earlier studies done by DEQ. Methods and procedures were also replicated to allow for comparison of pollutant loads delivered to the Snake River between 1986 and 1999.

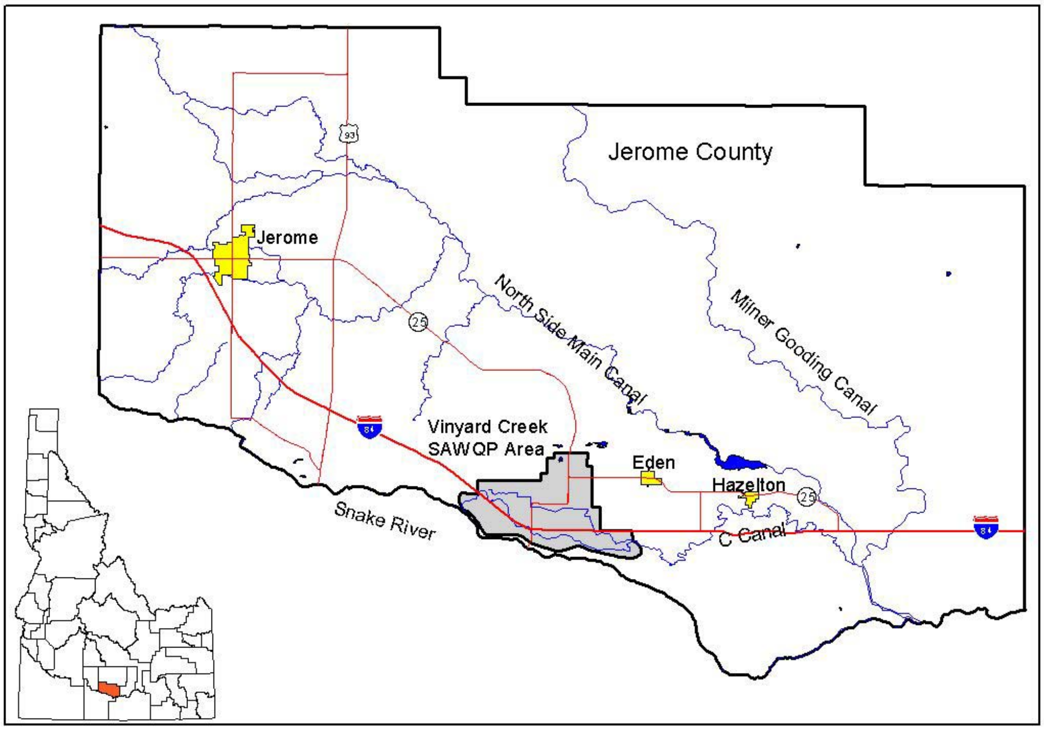

Figure 1. Jerome County, Idaho and the Vinyard Creek SAWQP Project Area.

The Upper Snake Rock TMDL

A Total Maximum Daily Load (TMDL) document has been developed for the Snake River and its tributaries between Milner Dam and King Hill. Tributaries included on the state of Idaho 303(d) list are specifically addressed in the TMDL and all tributaries to the Snake River must meet the criteria set in the TMDL for pollutant concentrations or loads.

The TMDL has set concentration standards for total suspended solids (TSS) and total phosphorous for tributaries of the Snake River, including the Vinyard Creek drain. Limits for total suspended solids (TSS), total phosphorous and fecal coliform bacteria are included in Table 1. Since this project ended, the state of Idaho has adopted E. Coli standards to replace those for fecal coliform. Since no E. Coli data was collected for this project, the previous fecal coliform state standards are listed.

Table 1. Upper Snake Rock TMDL Pollutant Limits

Pollutant	Upper Snake Rock TMDL Concentration Limit
Total Suspended Solids	52 mg/L monthly average maximum 80 mg/L daily average maximum
Total Phosphorous	0.10 mg/L for all tributaries of the Snake River
Fecal Coliform	500 colonies/100 mL (cfu) for primary contact recreation 800 cfu for secondary contact recreation

Project Objectives

Objectives for this monitoring project were established prior to monitoring in the spring of 1999 after several meetings with the North Side SWCD and were included in the project plan written at that time (Dallon, 1999). The objectives were to:

- Provide post implementation data for comparison of water quality conditions before the implementation of BMPs.
- Assess existing water quality conditions and impacts from agricultural activities.
- Use the data for public awareness.

Monitoring Sites and Methods

Monitoring Site Locations

Three sites in the watershed were chosen for monitoring. The sites, from downstream to upstream, are V1, V2 and V3 (Figure 2). The sites are described below.

V1 – Just above the canyon rim where the drain enters Snake River, ¾ mile from mouth.
V2 – Several hundred feet upstream of a large sediment pond along I-84, 1 mile upstream of V1.
V3 – On C canal at the upstream end of the project area, along Eden South Rd.

V2 and V3 were placed near sites used by DEQ between 1985 and 1993. These sites were labeled by DEQ as sites S3 and S4, respectively (Litke, 1989; Litke, 1991 and Tueller and Unland, 1993). Sites previously monitored on Vinyard Creek itself were not monitored because the relocation of the outlet of the drain in 1998 by Idaho Power has eliminated any effect of the drain on Vinyard Creek.

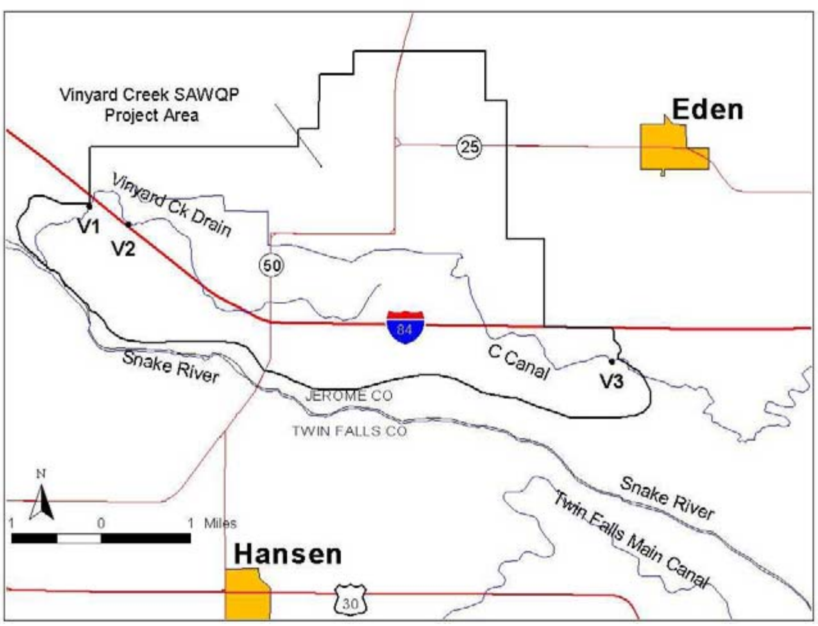

Figure 2. Vinyard Creek Monitoring Site Locations

Sampling Schedule

The sampling schedule was intended to correspond with the irrigation season. The first few weeks of flow in the drain were missed due to a late start with the monitoring. Sampling began on May 17, 1999 and continued until October 20, 1999. Irrigation ended in late October and the drain was dry by the beginning of November. Sampling was done twice a month for a total of 11 sampling events.

Sampling Methods and Parameters

Sample collection techniques followed approved United States Environmental Protection Agency (USEPA) and/or United State Geological Survey (USGS) methods. All analytical testing followed either USEPA or Standard Methods for the Examination of Water and Wastewater (SM) approved methods. Quality Control samples (duplicates and blanks) comprised 10 % of the sample load during this program. Quality Assurance and Quality Control (QA/QC) results are in Appendix A. The quality control samples were stored and shipped with the normal sample load for analytical testing. For project tracking, chain-of-custody protocols were followed for all sample handling. A detailed description of the procedures used is included below.

Flow Measurements

Flow measurements were collected with a Marsh McBirney Flow Mate Model 2000 flow meter. The six-tenth-depth method (0.6 of the total depth below water surface) was used when the depth of water was less than or equal to three feet. A transect line was set up perpendicular to flow across the width of the drain and the mid-section method for computing cross-sectional area along with the velocity-area method was used for discharge determination. The discharge was computed by summation of the products of the partial areas (partial sections) of the flow cross-sections and the average velocities for each of those sections.

Water Quality

Samples for water quality analysis were collected by grab sampling directly from the drains. For shallow drains six one liter grab samples were collected from a well-mixed section, near mid-stream at approximately mid-depth. For shallow sites (< 1ft) grab samples were collected by hand using a clean one-liter stainless steel container. At sites where the water depth was greater than 1 foot, a DH-81 integrated sampler was used. With all of the methods, individual samples were collected at equal intervals across the entire width of the drain or canal. A 2.5-gallon polyethylene churn sample splitter was used to composite each discrete sample. The composite sample was thoroughly homogenized and poured off into properly prepared sample containers. For samples requiring filtration (ortho-phosphate), a portion of the sample water was transferred into the filtration unit and pressure filtered through a 0.45 µm. GN-6 Gelman Metricel Filter. Water for nutrients that required preservation were transferred into preserved (H2SO4pH <2) 500 ml sample containers. The polyethylene churn splitter was thoroughly rinsed with source water at each location prior to sample collection. Bacteriological samples were collected directly from the midstream discharge into sterile sample bottles. Analytical methods, preservation and holding times for each parameter are included in Table 2.

Table 2. Water Quality Parameters

Parameters	Sample Size	Preservation	Holding Time	Method
Non Filterable Residue (TSS)	200 ml	Cool 4°C	7 days	EPA 160.2
Total Volatile Residue (TVSS)	200 ml	Cool 4°C	7 days	EPA 160.4
Nitrogen-nitrate/nitrite	50 ml	Cool 4°C, H_2SO_4 pH < 2	28 days	EPA 353.2
Nitrogen-Ammonia	50 ml	Cool 4°C, H_2SO_4 pH < 2	7 days	EPA 350.1
Total Kjeldahl Nitrogen	100 ml	Cool 4°C, H_2SO_4 pH < 2	7 days	EPA 351.2
Total Phosphorous	100 ml	Cool 4°C, H_2SO_4 pH < 2	28 days	EPA 365.4
Ortho phosphate	100 ml	Filtered, Cool 4°C	24 hours	EPA 365.2
Fecal Coliform	250 ml	Cool 4°C	30 hours	Standard Methods

Field Measurements

Field measurements for dissolved oxygen, specific conductance, pH, temperature and total dissolved solids were taken in well-mixed sections, near mid-stream at approximately mid-depth. Calibration of all field equipment was in accordance with manufacturer specifications. All field measurements were recorded in a bound logbook along with pertinent observations about the site, including weather conditions, flow rates and personnel on site. Refer to Table 3 for a list of field measurements, equipment and calibration techniques.

Table 3. Field Measurements

Parameters	Instrument	Calibration
Dissolved Oxygen	YSI Model 55	Ambient air calibration
Temperature	YSI Model 55	Centigrade thermometer
Conductance and TDS	Orion Model 115	Conductance standards
pH	Orion Model 210A	Standard buffer (7,10) bracketing for linearity

Results

Water Quality

Vinyard Creek water quality sampling and testing objectives were successfully met for the 1999 project. All samples were analyzed and processed within the required times and quality assurance and quality control (QA/QC) goals were met. Summary statistics are displayed in Table 4 for the three monitoring sites for the period of collection (May – Oct 1999). The data in Table 4 is from the 1999 monitoring season and includes the parameters of greatest concern with respect to the TMDL and water quality issues. Raw data for the entire project is included in Appendix B.

Table 4. Vinyard Creek Drain Water Quality Data (May-Oct 1999)

Parameters	Site	Mean	Median	St. Dev.	Minimum	Maximum	n
Discharge (cfs)	V1	2.08	1.84	1.12	0.63	3.84	11
	V2	2.83	3.06	1.44	0.13	4.80	11
TSS (mg/L)	V1	19	16	10.8	7	40	11
	V2	43	34	43.5	2	164	11
	V3	48	53	33.5	1	106	11
Nitrate + Nitrite (mg/L)	V1	0.27	0.23	0.19	0.07	0.80	11
	V2	0.23	0.24	0.08	0.06	0.35	11
	V3	0.26	0.23	0.13	0.05	0.57	11
Total Phosphorous (mg/L)	V1	0.10	0.09	0.05	0.01	0.20	11
	V2	0.14	0.13	0.07	0.01	0.25	11
	V3	0.13	0.14	0.07	0.01	0.25	11
Ortho-phosphate (mg/L)	V1	0.05	0.04	0.04	0.005	0.15	11
	V2	0.06	0.06	0.05	0.005	0.18	11
	V3	0.04	0.03	0.03	0.005	0.10	11
Fecal Coliform (cfu)	V1	896	400	1160	80	4000	11
	V2	1676	1500	1175	200	4500	11
	V3	168	30	284	10	900	11

Stream Discharge

Average flow rates at V1 and V2 were 2.08 and 2.83 cubic feet per second (cfs), respectively (Table 3). Flows ranged between 0.1 and 4.8 cfs at the two sites over the course of the project. The lower discharge at V1 is the result of an irrigation diversion between the two sites. Stream discharge data was not collected at site V3. Flows in the C Canal were > 150 cfs during most of the irrigation season. Flow in the canal is consistent during the irrigation season and is dependent on canal company operations, not irrigation runoff.

Total Suspended Solids

TSS concentrations generally decreased from the upper to lower end of the watershed during the 1999 irrigation season. Concentrations dropped from an average of 48 milligrams per liter (mg/L) in the C Canal to 43 mg/L at site V2 and 19 mg/L at V1. The suspended sediment load at site V1 was 215 lbs/day and as the site closest to the Snake River, best represents the load delivered to the Snake River from the Vinyard Creek drain. The load at V2 was significantly more at 651 lbs/day. An irrigation diversion and large sediment pond between the two sites decreased flow and allowed solids to settle out and reduced the load by 436 lbs/day from V2 to V1. The two sites are approximately 1 mile apart. Deposition of large amounts of sediment within the channel upstream of the sediment pond in low velocity sections was obvious as far upstream as site V2. The concentration and total load at site V1 never exceeded the 52 mg/L monthly average during this project.

Nitrate + Nitrite

All three sites were generally below the suggested levels of 0.30 mg/L. The TMDL did not set load or concentration limits on nitrogen in any form. The average concentrations at sites V1, V2 and V3 were 0.27 mg/L, 0.23 mg/L and 0.26 mg/L, all less than 0.30 mg/L.

Total Phosphorous

Total phosphorous concentrations in the project area averaged very near the 0.10 mg/L limit established in the TMDL (Table 1). Average concentrations of 0.10 mg/L at V1 and 0.14 mg/L at V2 were at or just above the limit. The total phosphorous load of 1.10 lbs/day at site V1 is the best representation of the load delivered to the Snake River and is nearly half of the 2.15 lbs/day load at V2. The concentration of 0.10 mg/L at V1 is equal to the 0.10 mg/L limit set by the TMDL for tributaries of the Snake River. Although not exceeding the limit, any increase in phosphorous levels will violate TMDL standards.

Orthophosphate

Concentrations of orthophosphate were similar over the three sites. From upstream to downstream the average concentrations were 0.04 mg/L, 0.06 mg/L and 0.05 mg/L (Table 3). No limit is set on orthophosphate specifically, but it is included as a part of the total phosphorous limit of a maximum of 0.10 mg/L. The total phosphorous fraction that is represented by orthophosphate increases from upstream to downstream simply because the total phosphorous concentration dropped while the orthophosphate concentration remained the same. Since the dissolved orthophosphate levels are constant, the drop in total phosphorous from V3 and V2 to V1 appears to be due to a drop in the non-dissolved portion of phosphorous, which is typically related to TSS levels. Orthophosphate accounted from 31% to 50% of the total phosphorous amounts at the three sites. Regardless, the total phosphorous level at V1 is within the TMDL limit and no reduction in orthophosphate is needed.

Fecal Coliform

Fecal coliform numbers for the 1999 irrigation season showed numerous exceedences of the 800 cfu fecal coliform standard. Individual sample values of fecal coliform bacteria are shown in Table 4. Shaded boxes indicate a value above the 800 cfu standard for secondary recreation. Four of the eleven samples exceeded the standard at V1, nine of eleven at site V2. Only one sample was greater than 800 cfu at site V3. Sites V1 and V2 show routine violations of the fecal coliform standard, particularly V2. Site V3 was generally below the standard.

Table 5. Fecal Coliform Levels, 1999

Units in colonies per 100 mL (cfu)

Date	V1	V2	V3
5/17/99	400	200	< 10
6/2/99	1400	2100	10
6/17/99	200	1000	30
7/7/99	520	2360	200
7/26/99	180	4500	30
8/9/99	4000	1000	30
8/23/99	1600	1200	900
9/8/99	1100	1800	120
9/23/99	200	1500	500
10/7/99	80	2300	<10
10/20/99	180	480	<10

Values above 800cfu standard are shaded

Bacterial contamination appears in this case to be very site specific. A corral located just upstream of site V2 directly on the main drain could be a main cause of the high bacteria levels at sites V2 and V1. Some livestock grazing in pasture upstream of the corral could also be a contributor, as could septic runoff from scattered homes along the drain. Although bacterial standards do not apply to the manmade waterway of the drain itself, delivery of high bacteria levels to the Snake River could potentially be of concern in Twin Falls Reservoir.

Comparison to Past Conditions

Land Use Changes

A main objective of this monitoring project was to compare present water quality conditions with those from previous years to evaluate changes in water quality. The Vinyard Creek SAWQP provided education, information and funding sources to landowners to implement best management practices. A main emphasis of the program was placed on conversion from flood surface irrigation to sprinkler irrigation. The number of acres converted in the Vinyard Creek watershed was significant and relevant to the results of this project. Although the Vinyard Creek SAWQP provided funding to many of the landowners that implemented BMPs during the project, many landowners implemented practices independently and without financial assistance. Regardless of the funding sources or motivations, there was a significant change from gravity to sprinkler irrigation in the project area. The land use percentages in 1986 and in 1999 are shown in Figure 3.

Irrigated cropland in the project area is 81% of the total area (North Side SCD, 1986). In 1986, 85% of the irrigated cropland, or 69% of the total, was gravity irrigated. In 1999, the percentage of gravity and sprinkler irrigated land had swapped and 90% of the irrigated cropland, or 73% of the total area, was under sprinkler irrigation.

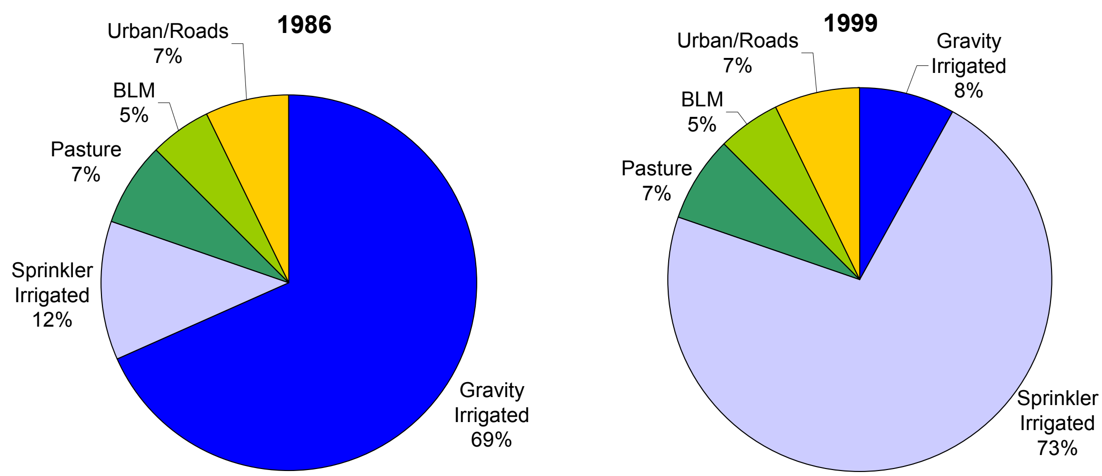

Figure 3. Land Use in SAWQP Project Area: 1986 and 1999

Data comparison: 1986, 1991 and 1999

DEQ data at the two downstream sites (V1 and V2) from 1986 and 1991 (Litke, 1989 and Tueller et. al., 1993) was used as comparison to the 1999 data. Data was compared over the same time frame for each of the three sampling years (May-Oct) for consistency. Tables 5 and 6 summarize data at sites V1 and V2, respectively, for each of the three years. Data from site V3 was not complete for 1986 and is not included in this summary.

Table 6. Site V1 Data (data from 1986, 1991 and 1999)

Parameters	Year	Mean	Minimum	Maximum	n
Discharge (cfs)	1986	7.67	2.87	14.1	12
	1991	6.26	1.50	15.0	13
	1999	2.08	0.63	3.8	11
TSS (mg/L)	1986	167	28	362	12
	1991	155	8	362	13
	1999	19	7	40	11
Total Phosphorous (mg/L)	1986	0.30	0.10	0.60	12
	1991	0.29	0.10	0.60	13
	1999	0.09	0.01	0.20	11
Fecal Coliform (CFU)	1986	2864	70	15000	12
	1991	985	50	3680	13
	1999	896	80	4000	11

Table 7. Site V2 Data (data from 1986, 1991 and 1999)

Parameters	Year	Mean	Minimum	Maximum	n
Discharge (cfs)	1986	28.5	8.5	45.8	12
	1991	23.2	13.4	30.2	13
	1999	2.8	0.13	4.8	11
TSS (mg/L)	1986	192	2	1060	12
	1991	178	2	1060	13
	1999	43	2	164	11
Total Phosphorous (mg/L)	1986	0.24	0.01	1.06	12
	1991	0.23	0.01	1.06	13
	1999	0.13	0.01	0.25	11
Fecal Coliform (cfu)	1986	1173	50	4800	12
	1991	203	5	800	13
	1999	1676	200	4500	11

Discussion

Stream Discharge

Stream discharge in the Vinyard Creek Drain decreased at both sites between 1986 and 1999. Flow in the drain at site V1 dropped 68% and at site V2 it dropped 90%. Flow in the drain is entirely dependent on irrigation management and agricultural runoff. There is only water in the drain during the irrigation season, so any reduction in flow is the result of changes in irrigation management. The change in irrigation systems from gravity to sprinkler between 1986 and 1999 is the primary factor in the reduction in agricultural runoff. Sprinkler irrigation is more efficient than gravity irrigation and less runoff occurs. Decreased runoff from agricultural fields delivered less sediment to the drain and lower flows in the drain had less energy with which to erode the drains banks and bed. Wastewater runoff to the Snake River was reduced substantially.

Total Suspended Solids

Total suspended solid (TSS) concentrations decreased at both sites between 1986 and 1999. Reductions in TSS concentration over the entire period at sites V1 and V2 were 89% and 78% respectively. The 1999 average levels of TSS at both V1 and V2 (19 mg/L and 43 mg/L) are well within the limit of 52 mg/L set in the Upper Snake Rock TMDL. Only one individual sample at station V2 exceeded the TMDL limit of 80 mg/L for a one-time measurement. A graphical analysis of TSS concentrations for the three sampling periods is shown in Figure 4.

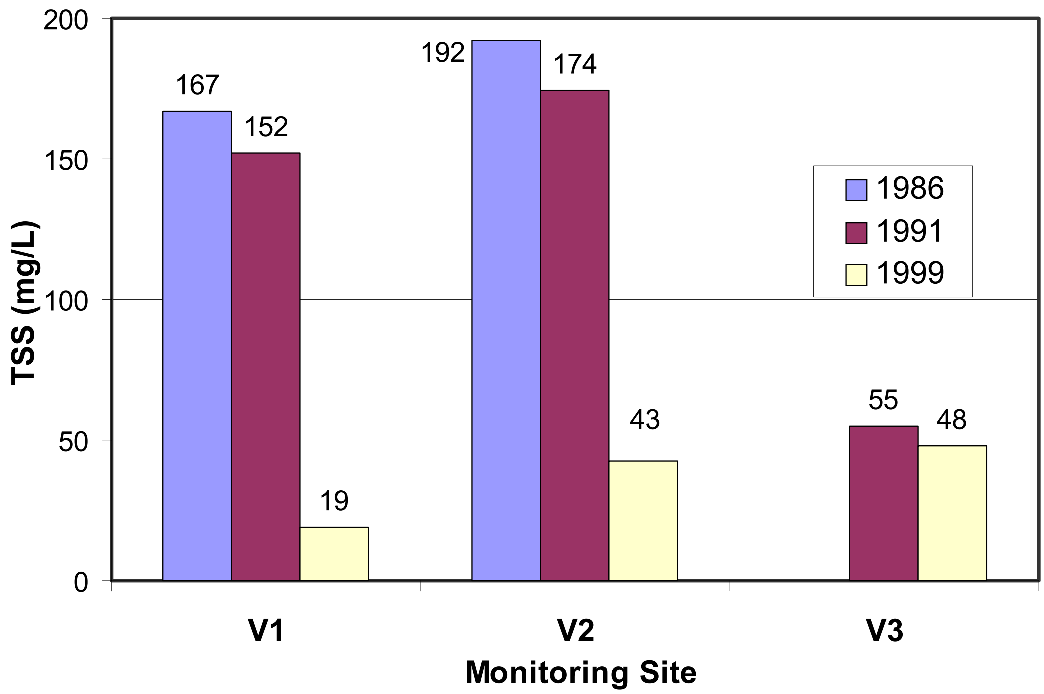

Figure 4. Average Total Suspended Solids Concentration: 1986 -1999

Since sediment concentrations and stream flow in the Vinyard Creek drain both decreased, sediment loads decreased substantially. Stream discharge decreased 68% and 90% at V1 and V2 from 1986 to 1999 while sediment concentrations decreased 89% and 78%, respectively. The combination of decreased TSS concentration and stream discharge resulted in a drop of sediment loads of 96% at site V1 and 98% at site V2 between 1986 and 1999 (Figure 5). The reduction in stream discharge is an important part of this evaluation. Reducing agricultural runoff and subsequent flow in the drain was a goal of BMPs implemented through the Vinyard Creek SAWQP. Reduction in TSS concentration, whether caused by reduced runoff from agricultural fields or by reduced flow energy within the drain channel, is the result of changes in management practices by area landowners.

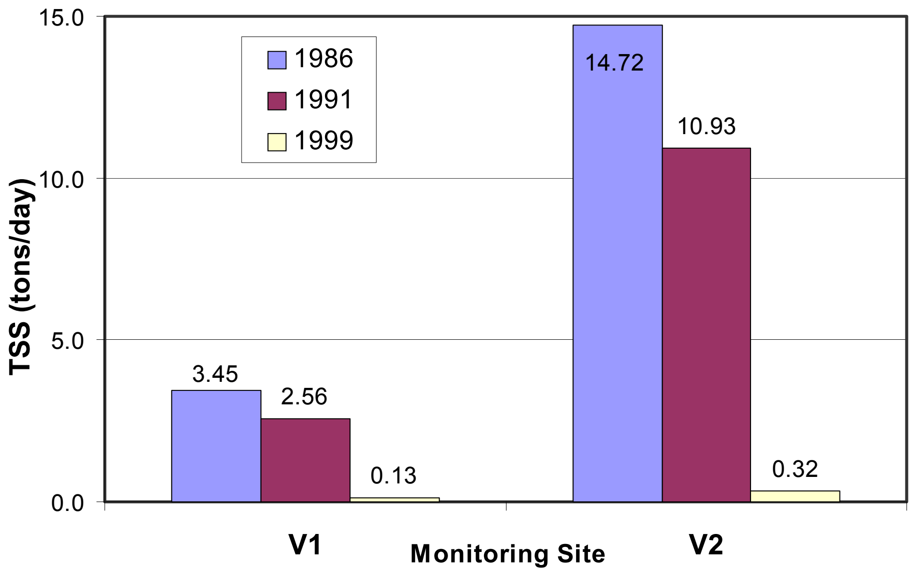

Figure 5. Average Total Suspended Solid Loads: 1986-1999

Phosphorous

Total phosphorous concentrations in the Vinyard Creek drain dropped significantly between 1986 and 1999. Annual means for 1999 were 0.10 mg/L at site V1 and 0.14 mg/L at site V2. These values represent reductions of 69% at both V1 and V2 since 1986. This decline in total phosphorous levels is most likely associated with the decrease in TSS over the same period. The 1999 data shows that 31%-50% of the phosphorous in the water column is in the dissolved orthophosphate phase, indicating that much of the phosphorous present currently is dissolved and not associated with sediment runoff. The total phosphorous average concentration of 0.10 mg/L at site V1 (near the mouth) is equal to the total phosphorous standard of 0.10 mg/L established in the Upper Snake Rock TMDL for tributaries of the Snake River.

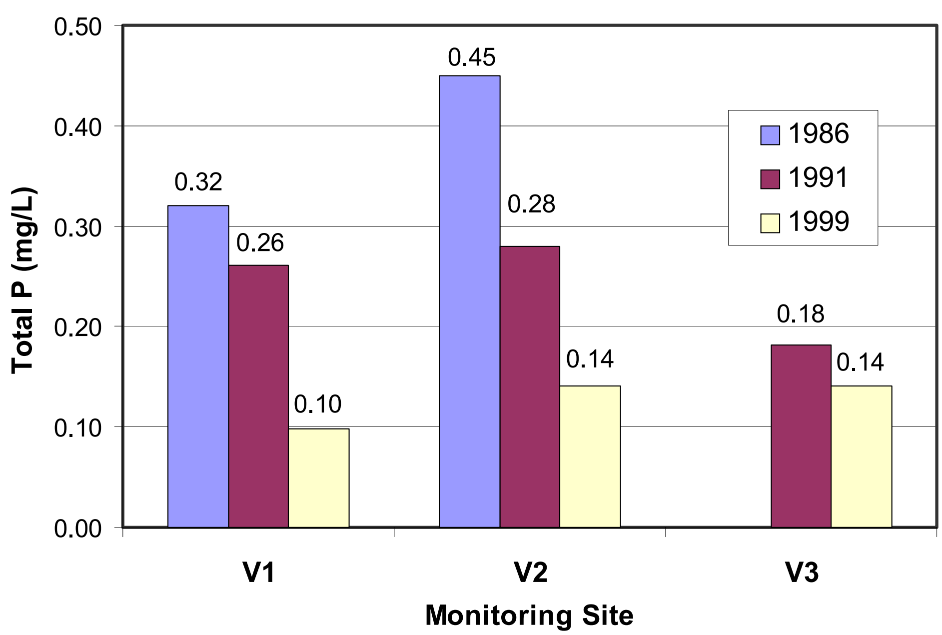

Figure 6. Average Total Phosphorous Concentration: 1986 -1999

Total phosphorous loads similarly dropped over the period of concern (see Figure 7). At site V1 loads decreased from 13.22 lbs/day in 1986 to 1.29 lbs/day in 1999. This represents a 90% reduction in phosphorous delivered to the Snake River. Loads at site V2 dropped from 69.02 lbs/day in 1986 to 2.13 lbs/day in 1999, representing a 97% reduction.

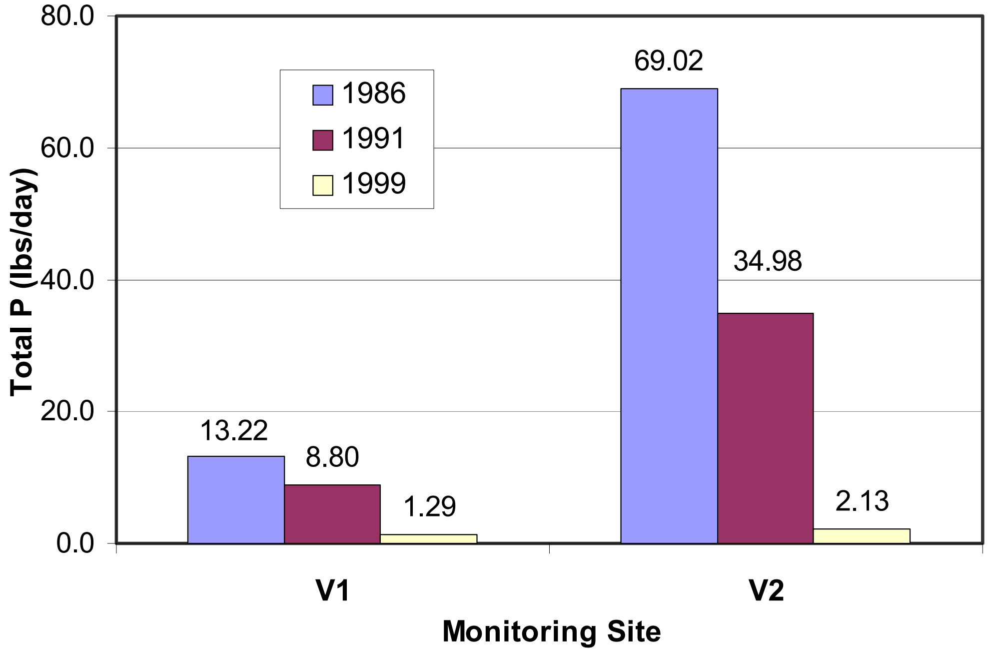

Figure 7. Average Total Phosphorous Loads: 1986 -1999

Fecal Coliform Bacteria

Fecal coliform bacteria had been used as the state of Idaho standard for pathogen contamination in surface water until the year 2000. The state standards for primary and secondary contact recreation are 500 and 800 colony forming units (cfu) respectively for a one-time measurement. Over the 13-year period of analysis fecal coliform numbers have seen considerable variation. The change in average fecal coliform numbers at each site is shown in Table 8. The average values in this table are not an indication of violation of the 800 cfu standard since the standard applies to one-time measurements over 800 cfu. It simply shows the change from year to year in average fecal coliform samples. To indicate the number of actual violations of the 800 cfu standard, Table 9 shows the number of samples greater than 800 cfu and the total number of samples collected for each year. This is a better indication of the percentage of time the standard is actually exceeded at each site.

Table 8. Fecal Coliform Average Values: 1986, 1991 and 1999

Year	V1 (cfu)	V2 (cfu)
1986	2864	1173
1991	985	203
1999	896	1676
% change 1986-1999	-68.7	+42.9

Table 9. Fecal Coliform % Exceedence

#Samples > 800cfu / Total Samples

Year	V1	V2
1986	11/12 **(92%)**	3/12 **(25%)**
1991	4/13 **(31%)**	1/13 **(8%)**
1999	4/11 **(36%)**	9/11 **(82%)**
% change 1986-1999	-56%	+57%

Average fecal coliform levels at site V1 decreased from 1986 to 1991 and again from 1991 to 1999. Site V2 saw a substantial decrease and then a substantial increase over the same periods. The percent of samples exceeding standards followed a similar pattern. Site V1 saw the percentage drop from 92% to 31% and then increase to 36% in 1999. Although there was an overall decline in average levels and number of standard violations over the 13 years, bacterial contamination still exists at this site.

Fecal coliform patterns at site V2 were variable. Both the average value and number of violations dropped from 1986 to 1991 and then rose substantially from 1991 to 1999. The percentage of samples exceeding the standard dropped from 25% to 8% and then increased markedly to 82%. Site V1 does not exhibit the same pattern as site V2, indicating that the high bacteria concentrations from site V2 are not necessarily impacting water quality at site V1 or in the Snake River. The pattern at V2 is of concern, however, and suggests specific changes have occurred in practices that affect bacterial contamination in surface water upstream of the site.

The rise in fecal coliform violations at site V2 is most likely caused by a combination of lower flows that concentrate bacteria and management of livestock corrals located upstream of the site. The corrals are located directly on the drain and provide direct and constant access to the water by livestock. Storm water and irrigation runoff over the bare soils and animal waste in the corrals is most likely the largest source of bacteria at sites V1 and V2. Inputs from livestock grazing in pastures upstream of V2 and the possibility of septic system contamination are also possibilities.

Conclusions

Monitoring on the Vinyard Creek drain has shown a substantial decrease in flow, total suspended solids and phosphorous concentrations from 1986 to 1999. At site V1, from 1986 to 1999, flow decreased by 73%, TSS concentration by 89% and total phosphorous concentration by 69%. The percentage of irrigated fields under sprinkler irrigation went from approximately 15% in 1986 to 90% in 1999. The change in irrigation practices is the primary cause of reduced runoff and delivery of pollutants. Current levels of sediment and phosphorous delivered to the Snake River from the drain are within the limits set by the Upper Snake Rock Total Maximum Daily Load. The North Side SWCD has been actively promoting programs and projects that decrease soil erosion and improve water quality.

Bacteria concentrations decreased by 66% at site V1 but increased by 43% at site V2 between 1986 and 1999. Violations of state water quality standards occurred at both sites, particularly at site V2. Fecal coliform bacteria levels are often above state standards and are due to localized, specific land use problems.

Recommendations

To ensure that sediment and phosphorous levels remain at current levels, maintaining best management practices that prevent erosion of soil from agricultural fields and delivery to stream channels or drains should be a priority in the watershed. The sharp decrease in sediment and nutrients delivered to the Snake River from the Vinyard Creek watershed was the result of focused efforts to reduce tail water runoff and prevent soil erosion from cropland. This emphasis should continue. The North Side SWCD, the North Side Canal Company and individual landowners should continue to maintain practices that prevent soil from being eroded from the field.

Bacteria levels were above state standards for much of the 1999-irrigation season. Eliminating direct access to the drain by livestock within confined areas should be emphasized. Runoff into the drain and open waterways from corrals should be minimized. Efforts with specific landowners to move corrals and manage grazing in pastures would be the most effective agricultural management practices to reduce bacterial contamination in the drain.

References

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Appendix A
Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC)

Procedures for quality assurance and quality control for this project were outlined prior to monitoring in April of 1999 (Dallon, 1999). Magic Valley Labs in Twin Falls, Idaho Falls analyzed all samples. Magic Valley Labs uses EPA approved and validated methods.

Duplicate samples and blank samples were collected as part of the field QA/QC procedures. Duplicates and blanks were collected at 10% of the total sample load. Blank samples consisted of deionized water handled as if it were a normal sample. For samples requiring filtering, deionized water was put through the filtration unit and transferred to a sample container. There were no constituents detected above the detection limit for any of the blank samples analyzed during this project.

All of the duplicate samples were collected from site V1on the Vinyard Creek drain. Duplicate samples were not identified as such during analysis by the laboratory to determine field and laboratory precision. Blank and duplicate samples were stored, handled and transported with the other samples to the laboratory. A comparison of mean values for parameters when duplicates were collected and the mean value of duplicate samples for those parameters is presented in Table 10. This table is not an indication of precision between individual measurements, but of the mean values of samples and duplicate samples.

Table 10. Duplicate Sample Comparison

Parameters	V1 Mean	Duplicate Mean	Percent
TSS	18.0	18.3	101.4
TVSS	8.3	9.0	108.0
Nitrate	0.20	0.21	105.0
TKN	0.70	0.84	120.4
Ammonia	0.04	0.03	86.2
Total P	0.08	0.09	116.1
Orthophosphate	0.05	0.07	142.1
Fecal Coliform	900	725	80.6

The relative percent difference (RPD) between each individual sample and its corresponding duplicate sample are presented in Table 6. The RPD is a measure of precision for duplicate samples and is calculated with the following equation:

$$RPD = \frac{(C_1 - C_2) \times 100\%}{(C_1 + C_2) / 2}$$

RPD = relative percent difference
C_1 = Larger of two samples
C_2 = Smaller of two samples

Table 11. Relative Percent Difference (duplicates)

Collection Date	TSS	TSS Duplicate	RPD	Total P	Total P Duplicate	RPD	Fecal Coliform	Fecal Coliform Duplicate	RPD
6/02/99	29	28	3.5	0.12	0.13	8.0	1400	1500	6.9
7/7/99	10	12	18.2	0.05	0.07	33.3	520	500	3.9
8/23/99	26	27	3.8	0.09	0.10	10.5	1600	800	66.7
10/7/99	7	6	15.4	0.05	0.06	18.2	80	100	22.2
Collection Date	**NO_3**	**NO_3 Duplicate**	**RPD**	**NH_3**	**NH_3 Duplicate**	**RPD**	**TKN**	**TKN Duplicate**	**RPD**
6/02/99	0.22	0.21	4.7	<0.05	<0.05	0.0	0.30	0.60	66.67
7/7/99	0.07	0.06	15.4	0.07	0.05	33.3	0.75	0.75	0.00
8/23/99	0.19	0.20	5.1	<0.05	<0.05	0.0	1.48	1.77	17.85
10/7/99	0.32	0.37	14.5	<0.05	<0.05	0.0	0.26	0.24	8.00

Precision in the measurements was good for total suspended solids, total volatile suspended solids, total phosphorous, nitrate and ammonia. Precision was fair for fecal coliform, total kjeldahl nitrogen and orthophosphate.

Appendix B
Water Quality Data Sheets

Data Sheets - Vinyard Creek Drain

Site V1

Date	Q ft^3/s	DO mg/L	Temp Cel	Cond µS	TDS mg/L	pH	TSS mg/L	TVSS mg/L	NO3 mg/L	NO2 mg/L	Total P mg/L	Ortho P mg/L	NH3 mg/L	TKN mg/L	Fecal cfu/100mL
17-May-99	2.5	10.01	10.3	477	227	8.48	40	14	0.80	<0.003	0.20	0.080	-	-	400
2-Jun-99	1.8	8.06	14.7	430	205	8.44	29	7	0.22	0.003	0.12	0.070	<0.05	0.30	1400
17-Jun-99	3.8	8.00	18.2	352	168	8.33	10	8	0.11	0.003	0.05	<0.005	<0.05	1.10	200
7-Jul-99	2.0	7.71	20.2	315	150	8.10	10	9	0.07	<0.003	0.05	0.050	0.07	0.75	520
26-Jul-99	1.8	5.11	18.3	318	152	8.06	28	8	0.23	<0.003	0.11	0.041	0.07	1.92	180
9-Aug-99	1.8	8.01	18.9	319	152	8.18	9	7	0.26	0.004	<0.01	<0.005	<0.05	1.32	4000
23-Aug-99	2.9	7.90	19.5	360	172	8.10	26	9	0.19	<0.003	0.09	0.020	<0.05	1.48	1600
8-Sep-99	3.8	9.19	12.4	363	172	8.21	25	7	0.21	<0.003	0.10	0.040	<0.05	0.47	1100
23-Sep-99	0.6	8.70	14.8	385	183	8.18	11	4	0.32	0.006	0.15	0.150	<0.05	1.00	200
7-Oct-99	0.8	10.01	8.8	390	184	8.44	7	<1	0.32	0.004	0.05	0.050	<0.05	0.26	80
20-Oct-99	0.9	11.18	4.5	426	193	8.41	16	6	0.25	0.003	0.06	0.010	<0.05	0.96	180

Site V2

Date	Q ft^3/s	DO mg/L	Temp Cel	Cond µS	TDS mg/L	pH	TSS mg/L	TVSS mg/L	NO3 mg/L	NO2 mg/L	Total P mg/L	Ortho P mg/L	NH3 mg/L	TKN mg/L	Fecal cfu/100mL
17-May-99	4.7	9.70	11.0	490	233	8.61	164	38	0.24	0.004	0.25	0.060	-	-	200
2-Jun-99	2.7	8.27	14.6	436	207	8.50	50	14	0.26	0.004	0.13	0.100	<0.05	0.60	2100
17-Jun-99	2.6	8.35	19.0	344	164	8.52	34	13	0.12	<0.003	0.13	<0.005	<0.05	1.80	1000
7-Jul-99	3.3	7.68	20.0	313	149	8.35	39	14	0.06	<0.003	0.17	0.030	<0.05	0.60	2360
26-Jul-99	3.1	7.80	20.3	315	150	8.58	34	11	0.31	0.003	0.17	0.067	0.07	1.29	4500
9-Aug-99	4.8	7.76	20.6	324	154	8.42	44	10	0.18	0.007	<0.01	<0.005	<0.05	2.77	1000
23-Aug-99	3.5	7.69	20.5	357	170	8.36	52	13	0.28	<0.003	0.15	0.050	<0.05	1.41	1200
8-Sep-99	3.5	9.02	13.3	355	169	8.26	29	7	0.19	<0.003	0.10	0.060	<0.05	0.98	1800
23-Sep-99	2.1	8.49	16.3	376	179	8.40	15	4	0.26	0.007	0.18	0.180	<0.05	1.29	1500
7-Oct-99	0.1	9.71	10.0	388	184	8.73	2	<1	0.34	0.005	0.08	0.080	<0.05	1.92	2300
20-Oct-99	0.7	10.85	5.6	409	190	8.46	7	5	0.24	0.004	0.05	0.020	<0.05	0.97	480

Site V3															
Date	**Q** ft^3/s	**DO mg/L**	**Temp Cel**	**Cond µS**	**TDS mg/L**	**pH**	**TSS mg/L**	**TVSS mg/L**	**NO3 mg/L**	**NO2 mg/L**	**Total P mg/L**	**Ortho P mg/L**	**NH3 mg/L**	**TKN mg/L**	**Fecal cfu/100mL**
17-May-99	-	10.60	10.5	469	225	8.59	48	14	0.30	0.005	0.18	< 0.050	-	-	< 10
2-Jun-99	-	8.66	14.1	441	210	8.57	60	11	0.30	0.005	0.15	0.040	<0.05	0.45	10
17-Jun-99	-	8.71	18.2	343	164	8.63	53	42	0.20	0.005	<0.01	<0.005	<0.05	2.00	30
7-Jul-99	-	8.00	19.2	311	148	8.65	88	15	<0.06	<0.003	0.20	<0.005	<0.05	0.30	200
26-Jul-99	-	7.75	20.6	307	146	8.20	106	17	0.23	<0.003	0.25	0.021	0.06	1.93	30
9-Aug-99	-	7.70	20.9	316	150	8.66	54	13	0.17	<0.003	0.14	0.030	<0.05	1.51	30
23-Aug-99	-	7.68	20.8	358	170	8.60	55	12	0.23	<0.003	0.16	0.030	<0.05	1.76	900
8-Sep-99	-	8.58	15.4	354	168	8.62	51	12	0.18	<0.003	0.09	0.040	<0.05	1.73	120
23-Sep-99	-	8.32	16.9	367	175	8.55	4	2	0.26	0.003	0.10	0.100	<0.05	1.38	500
7-Oct-99	-	9.74	10.0	397	188	8.54	1	<1	0.47	0.100	0.08	0.080	<0.05	3.78	<10
20-Oct-99	67.3	10.25	8.0	410	193	8.63	5	4	0.33	0.008	0.06	0.060	<0.05	0.99	<10